NEW ENGLAND WATER WORKS ASSOCIATION.

ORGANIZED 1882.

Vol. I. Dec. 1886. No. 2.

This Association, as a Body, is not responsible for statements or opinions of any of its members.

QUARTERLY MEETING AT LAWRENCE,

WEDNESDAY, SEPT., 15, 1886.

At the invitation of Pres't. Rogers the September "Field Day" was held at Lawrence, Mass., and proved to be one of interest and profit.

The guests were received at the depot by the committee and conveyed to the City Hall, where introductions were in order until quarter past ten when the party assembled in the Common Council room, where Mayor Bruce made an address of welcome, in which he expressed the hope that the day was near when the water works system in all the cities of the United States will be as perfect as those presented on that occasion. This was responded to by Superintendent Rogers, and Superintendent Billings of Taunton. After partaking of a lunch provided in the Council room, the party boarded five large barges, and were taken to the Pacific Mills, where they were met by Superintendents Stone and Parker, who escorted them through the several departments and explained the process of manufacturing goods of cotton and woolen texture. Here a stay of about an hour was made and there were not a few who would gladly have lingered to examine more carefully the wonderful establishments of which the visitors could of necessity get only a glimpse. This is the largest textile manufacturing corporation in the world and in this connection the following figures are worthy of note:

Capital Stock,	$2,500,000.00
Divided into shares of $1,000 each, which are owned by 385 stockholders.	
There are in these mills:	
4 large Steam engines of	3,500 H. P.
42 small Steam Engines,	
50 Steam boilers,	
11 Turbine wheels of	5,000 H. P.
Annual consumption of Coal,	25,000 tons.
Annual consumption of gas, in 9,000 burners costs,	$35,000.00
Annual consumption of Cotton,	15,600 bales.

Annual consumption of Wool, 4,000,000 pounds.
being the product of 750,000 sheep.

Annual Capacity:
Cottons, printed and dyed, 65,000,000 yards.
Worsted Goods, 35,000,000 "
or a total of one hundred millions yards, equal to two and and a quarter times the distance around the world!

To make this cloth, nearly two hundred millions miles of yarn are required!

To do this work, thirty-six hundred females and nineteen hundred males, or a total of fifty-five hundred persons, are employed.

The pay-roll for the year ending May, 1884, amounted to, $1,790,000.00

After leaving the Pacific Mills the party returned to the City Hall at 12.30 p. m. and shortly after were driven to the pumping station where the compound Leavitt engines formed the chief object of interest. The reservoir was next visited, after which the visitors returned to the city proper by a circuitous route which afforded them an ample view of the Spicket improvements, the House of Correction, St. Mary's Church, the Common, and other attractive features about the city. In order to demonstrate the efficiency and promptness of the fire department in responding to alarms, Chief Merrill, for the instruction of the visitors pulled in an alarm from Box 13, at the police station, to which the whole department responds, on the first alarm. The chemical was the first to reach the corner of Essex and Lawrence streets, arriving in eighty-five seconds, closely followed by hose 5. The Washington steamer came next, and at nearly the same time, Atlantic 2 hose wagon came up, their time being two minutes and three seconds. The Franklin hook and ladder arrived in two minutes and forty seconds Atlantic steamer, two minutes, twenty-five seconds; Essex hose wagon, 3 minutes, thirty seconds; Tiger hose wagon, four minutes, forty seven seconds; Tiger steamer, four minutes, thirty-seconds.

After the exhibition the party repaired to the City Hall, where an ample and substantial repast was served by Landlord Hanrahan of the Brunswick. Three of the five long tables were occupied by the visitors and invited guests, and subsequently the firemen were invited to seats at the remaining tables. Dinner over, cigars were lit, and Mayor Bruce rapped for order. Remarks were made by Vice President Westcott of the Association, Commissioner Hawes of Fall River, Supt. Darling of Pawtucket. Ex-Mayor Breen, Mayor Kimball, of Newton, E. F. O'Sullivan, Dr. A. J. French, Duncan Wood, and several others. Mayor Bruce then declared the meeting adjourned, and the visitors departed for their homes, evidently well pleased with the courtesy and attention they had received.

At the meeting there were the following members present:—
Wm. R. Billings, Taunton.
R. C. P. Coggeshall, New Bedford.
Frank E. Hall, Quincy.
A. S. Glover. Newton.

Thos. C. Lovell, Fitchburg.
Geo. E. Winslow, Waltham.
A. B. Drake, New Bedford.
David B. Kempton, New Bedford.
A. S. Negus, New Bedford.
N. Dennett, Somerville.
Gilbert Murdock, St. Johns N. B.
E. S. Brown, Brockton.
D. W. Horan, Clinton.
J. H. Perkins, Watertown.
A. F. Noyes, Newton.
B. S. Grush, Salem.
Phineas Sprague, Malden.
Robert M. Gow, Medford.
Ward W. Hawkes, Malden.
Edwin Darling, Pawtucket.
Geo. E. Batchelder, Worcester.
H. G. Holden, Lowell.
F F. Forbes, Brookline.
J. H.Brown, Charlestown.
Patrick Kieran, Fall River.
C. K. Walker, Manchester.
Wm. B. Sherman, Providence.
Geo. R. Wescott, Portland.
W. S. Chaplin, Cambridge.
Hiram Nevons, Cambridge.
Wm. M. Hawes, Fall River.
J. A. Tilden, Hersey Meter Co.
Chapman Valve Co. Walworth Mfg. Co. Union Meter Co.
J. C. Kelley, Crown Meter Co.
Chas. H. Baldwin.
Mayor Kimball, Newton.
Mayor George H. Stearns, Manchester.
Levi C. Wedleigh, President Haverhill Aqd. Co.
D. B. Gardner, member Salem Water Board.
Walter Coburn, President Lowell Water Board.
Daniel Russell, Everett.
John Harris, Waltham.
C. W. Seymour, Hingham.
J. W. Morse, Natick,
A. G. Perry, Spencer.
J. E. Beals, Middleboro.
H. B. Winship, Norwich, Conn.
T. H. Barnes, Waltham.
W. H. Bennett, City Engineer.
J. B. Mills of the "Manchester Union."
Aldermen L. B. Bodwell, C. D. Welch, L. P. Reynolds, S. P. Conor, and A. J. Sanborn all of Manchester.

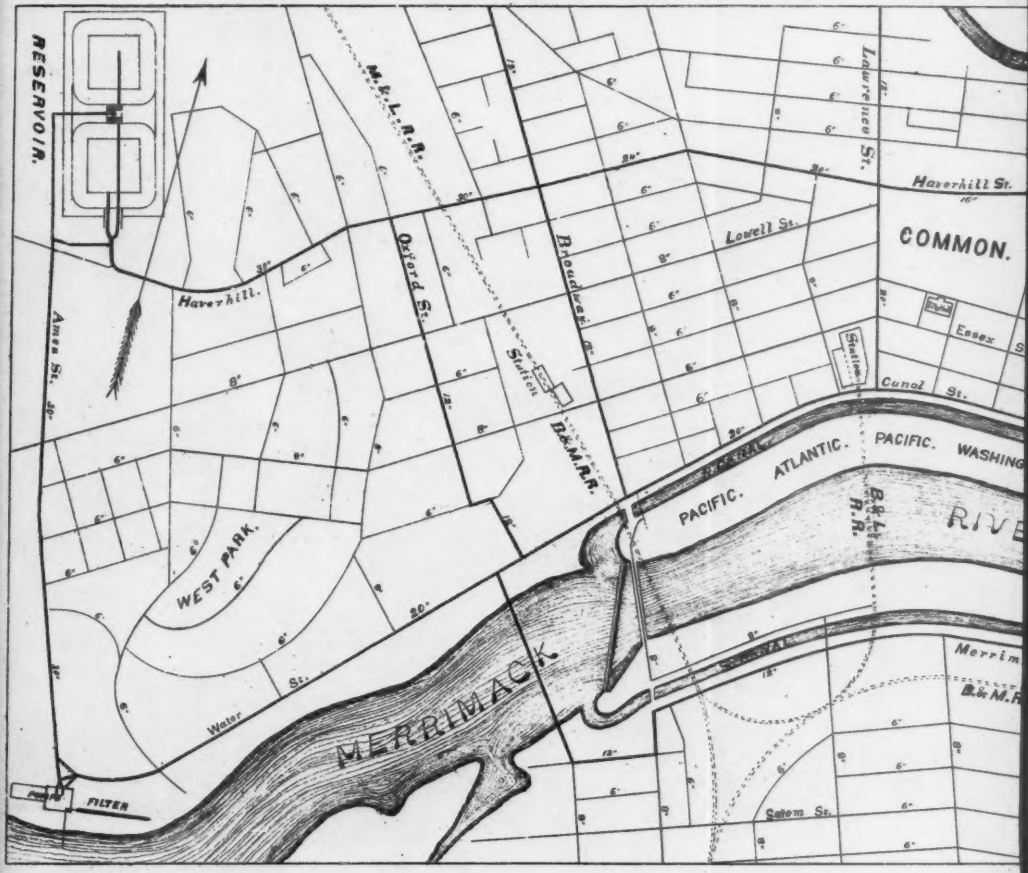
Owing to an unfortunate accident the foregoing list cannot be regarded as certainly correct, and if any member who was present finds his name omitted we trust he will pardon the unintentional omission.

LAWRENCE WATER WORKS.

BY H. W. ROGERS.

Although but forty years have elapsed since the first dwelling was erected in Lawrence, which to that time had been a wilderness, the town did not grow to its present proportions with forty thousand inhabitants without the struggles and agitations which are always necessary to bring about reform. We find as early as 1843, only two years after the first settlement, that the late Daniel Saunders with several of his worthy associates procured a charter for the construction of water works, under the name of the "Lawrence Aqueduct Company," the water to be brought from Haggett's Pond in Andover, but they had in some way reckoned without their host and the project fell through. *Public* water works were far less popular in those days than they have since become, and though the subject was more or less agitated, the young town was so frequently called upon to make large expenditures in other directions, that a *public* water supply was considered beyond its means. So in 1851 the Essex Company and the Bay State Mills joined in the construction of a reservoir of 1,500,000 gallons capacity on Prospect Hill, with an elevation of 152 feet above crest of dam, for the supply of the several manufacturing corporations, each having a separate system of distribution; the Bay State Mills pumping the water from the canal. Later, six of the other leading corporations joined in the enterprise and organized under the name of the "Lawrence Reservoir Association," each doing a share of the pumping into one common main from which any surplus over the day's consumption found its way into the reservoir, and was drawn back during the night. By an arrangement between the City Council and Reservoir Association, pipes were laid from this main through some of the principal streets of the city, and hydrants established for fire protection. This state of things continued for over twenty years, the population, meantime, increasing very rapidly and buildings being placed so compactly, that in the absence of any system of sewerage, the wells and cesspools became so mixed that in some cases it was said to be difficult to tell one from the other, and the necessity for a purer supply of water appeared so urgent that the agitation during the years 1871 and 1872 became general and earnest, resulting in the passage of an enabling act by the Legislature which was approved by Gov. Wm. B. Washburn, March 8, 1872. This act provided for the appointment of Commissioners, taking land, raising money, and other matters. Although the acceptance of the act by the legal voters was very bitterly opposed by many it was however approved on May 2nd by a large majority, and a joint special committee on water appointed, of which James Payne, Esq., was chairman. This committee were fortunate in the choice of L. Fred Rice of Boston as Consulting Engineer, who, after making the necessary surveys and giving the matter due study made a very able and exhaustive report materially shaping the course to be pursued by the constructing commis-

SHOWING RELATIVE POSITION OF PUMPS, RESERVOIR AND PIPE LINES. LAWRENCE WATER



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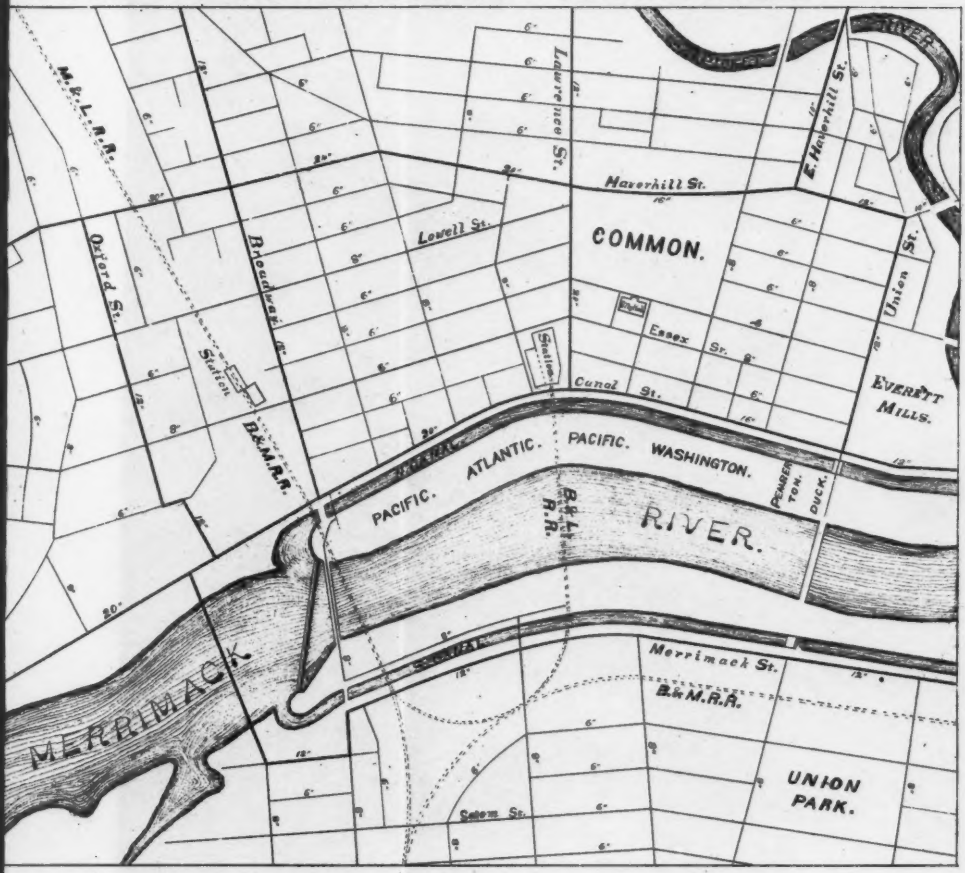

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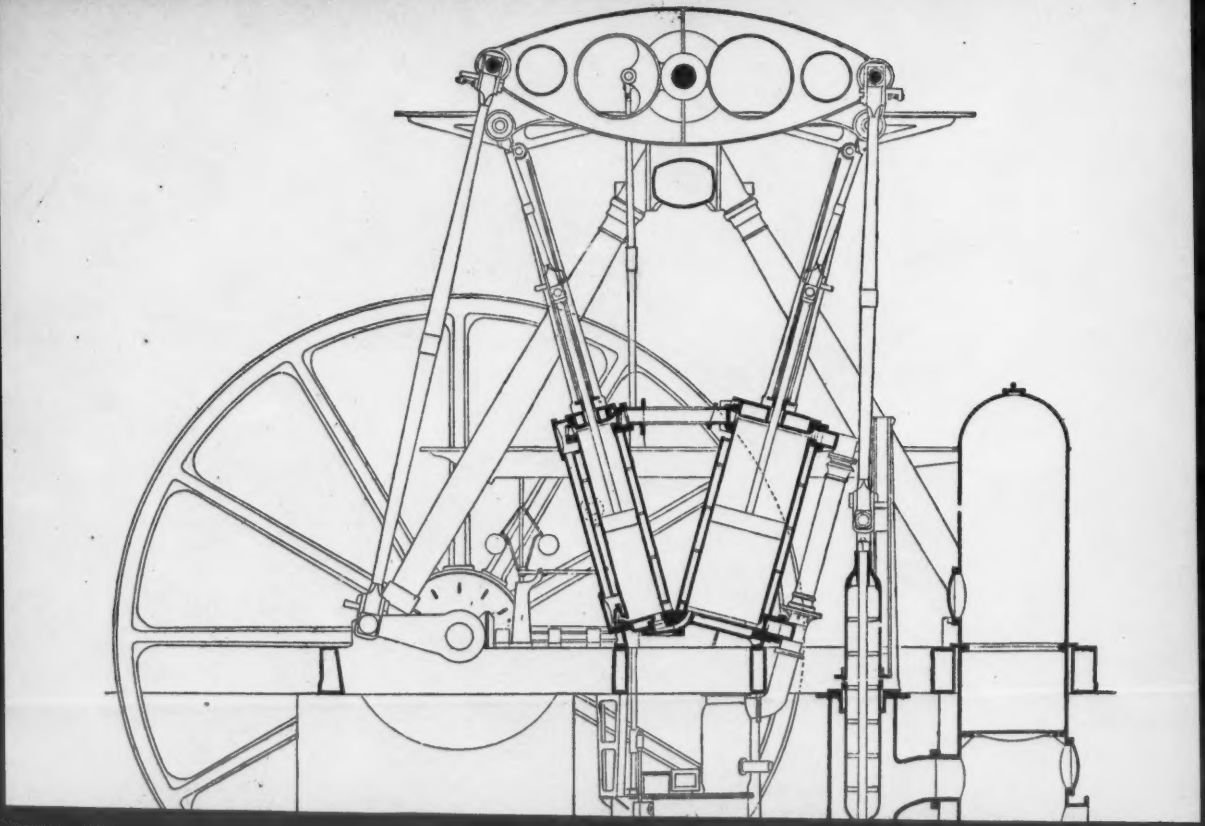
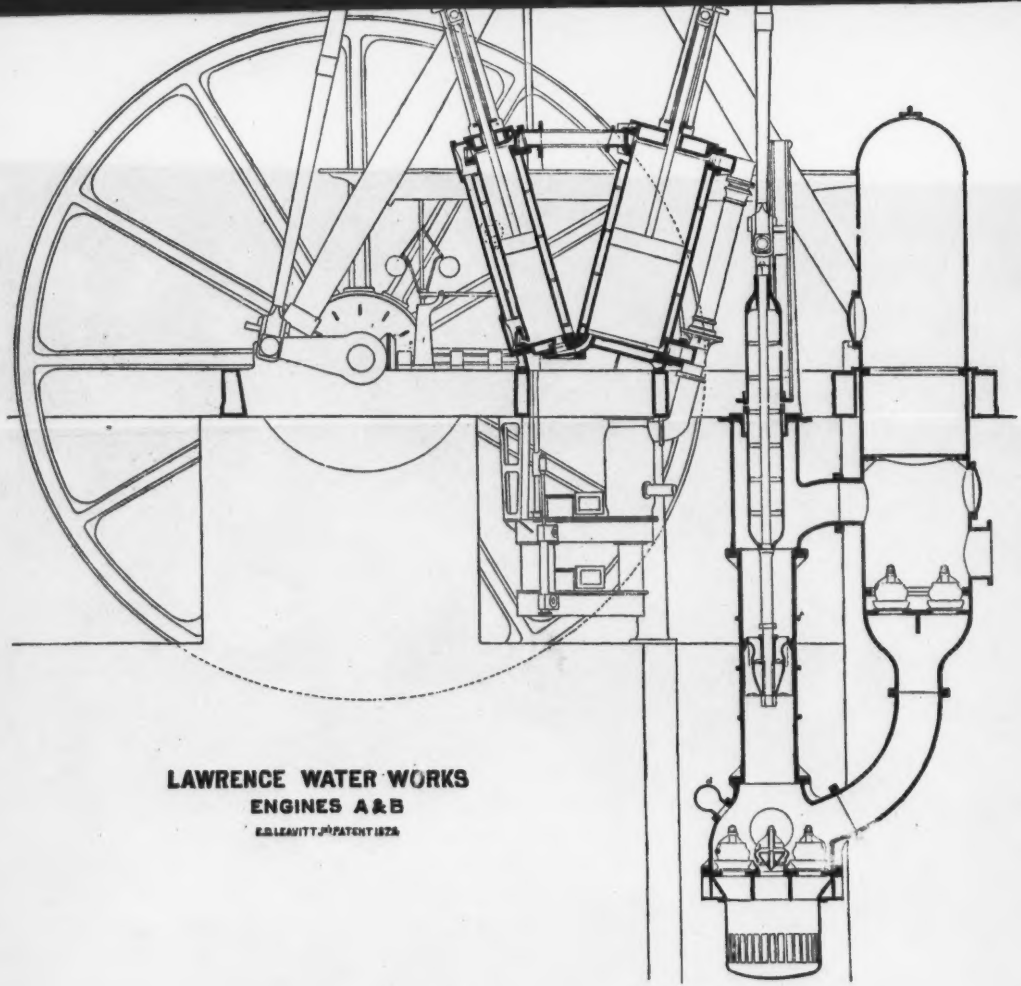




LAWRENCE WATER WORKS

ENGINES A&B

E.D. LEAVITT Jr. PATENT 1874

sioners, Messrs. William Barbour, Patrick Murphy and Morris Knowles, who were elected as such on the 8th of May in the year following, and with W. F. McConnell as engineer, and James P. Kirkwood, Esq., of Brooklyn, N. Y., as consulting engineer began at once the construction of the present system of water works. The Merrimack River, at a point a little less than a mile above the dam of the Essex Company, was chosen as the source, and pumping to distributing reservoir the plan adopted, and the result of the labors of these far-seeing and energetic men is one of the most complete and efficient plants in the country. The pumping station is situated on the north bank of the river, at a point forty-seven hundred feet west from Broadway, one of the principal streets of the city. The buildings are built of face brick with freestone trimmings, and slate roof, with the exception of the coal shed, which, being at the level of the ground, is constructed of brick arches laid on wrought iron girders, a layer of gravel over this, and the whole covered with concrete. This peculiar arrangement admits of the coal being hauled directly over the roof, and dumped into the coal room through scuttles without re-handling. The buildings rest upon a solid foundation of rubble masonry, laid in hydraulic cement, which extends to a depth of twenty-two feet below the floor line of the basement.

The engine house is sixty-six feet square on the exterior, and fifty-six feet from floor line to apex of roof. The boiler house is fifty-seven feet nine inches by fifty-five feet, and forty-two feet six inches in height. The coal room is in interior dimensions fifty-one feet nine inches by fifty-eight, and twelve feet in height, with a storage capacity of eight hundred tons of coal. The boiler-room is in the interior forty-five by fifty-one feet and six inches, with a total height from top of floor line of thirty-eight feet. The engine room is in interior dimensions sixty-two feet square, and fifty-two feet in height.

The main room is lighted by ten large windows and all necessary offices and store rooms are conveniently arranged. The buildings are heated by steam and are practically fire-proof. The chimney is located at the west end of the boiler house, passing up through the coal room, and is in height one hundred and eighty-three feet above floor line. The supply for the pumps which is taken directly from the river, is introduced through a conduit extending from the pumping station into the river, one hundred and seventy feet. A filter gallery, three hundred feet long and eight feet in vertical and horizontal diameter, extends east from the building, along the bank of the river, the side walls are built of rubble masonry laid in cement and roofed in with an arch of brick. At the bottom are cross braces of granite blocks eight feet long and one foot square laid ten feet apart and filled to the surface with small stones.

The pumping engines were built by I. P. Morris & Co., at the Port Richmond Iron Works, Philadelphia, from the designs and under the patent of E. D. Leavitt, Jr., of Cambridge, Mass.

They are overhead beam engines, with compound cylinders, and are both coupled to the same fly-wheel shaft by cranks set at right angles with each other.

The general appearance of the engines is massive and imposing, giving an impression of strength and solidity, with a judicious disposition of material.

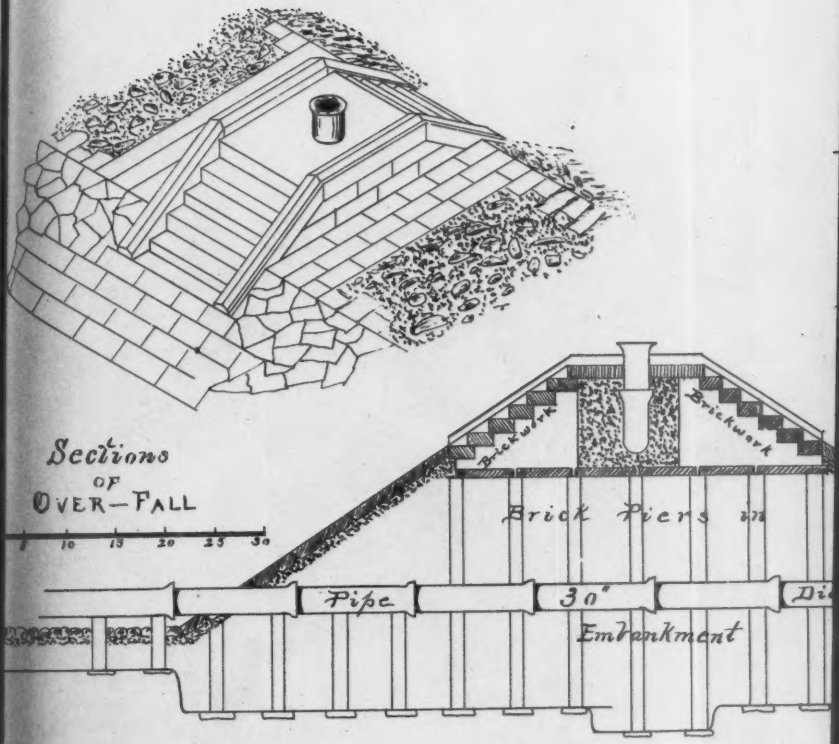
The principal dimensions are as follows:

Diameter of high pressure cylinders,	18 inches.
" low " "	38 "
" working barrel of pumps,	26 1-8 "
" pump plungers,	18 1-8 "
" fly wheel,	30 feet.
" air vessels,	54 inches.
" air pumps,	15 "
" main journals,	14 "
" main shaft on body,	16 "
" double beat valves outside,	15 3-4 "
" " " inside,	12 1-2 "
Length of stroke of steam and water pistons,	8 feet.
" cranks between centres,	4 "
" between end centres of beams,	16 "
" of stroke in air pumps,	28 inches.
" bed plates over all,	33 ft. 7 5-8 in.
" engines "	42 ft. 6 5-8 in.
Width of " "	28 ft. 1-2 in.
" each bedplate, extreme,	9 ft. 10 1-2 in.
Distance vertically from top of beams to bottom of pumps.	55 feet.
Approximate weight of each bedplate,	30 tons.
" " " beam,	13 "
" " " pump complete,	38 "
" " fly wheel,	18 "
" " shaft and cranks,	10 "
" " both engines complete,	310 "

The capacity of each engine is two hundred thousand gallons per hour, running at a speed of sixteen revolutions per minute.

The pumps discharge into a force main line of cast iron pipe, thirty inches in diameter, laid in the centre of Ames street, extending to the reservoir, and in extreme length about five thousand feet. In order that the force main might be utilized as a supply main, as has often been necessary when having the supply main shut off for making connections or repairs, it was laid with a fall to the river. and to avoid very deep cutting a brick tunnel six feet high and seven feet wide, egg shaped, with flattened bottom, was made through Emery's Hill a distance of nine hundred feet.

The reservoir is situated on Bodwell's Hill, in the western part of the city, about one and one-eighth miles from the the City Hall. It is of rectangular form, seven hundred and thirty feet long, and four hundred and eleven feet wide, measured on top in the centre of the embankment, and twenty-eight feet deep, with a division embankment, forming two basins, having a total capacity of 40,000,000 gallons when filled to the high water mark, which is twenty-five feet from the bottom. The top of the division embankment is six feet lower than the other embankments, so that when the reservoir is full to the high water mark, that is three feet from the top, there will be three feet of water over the division embankment, thus making it appear as one basin. The overfall is located in the centre of this embankment where the water from the force main discharges through a bell-shaped pipe, specially designed for this purpose, upon a stone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OF
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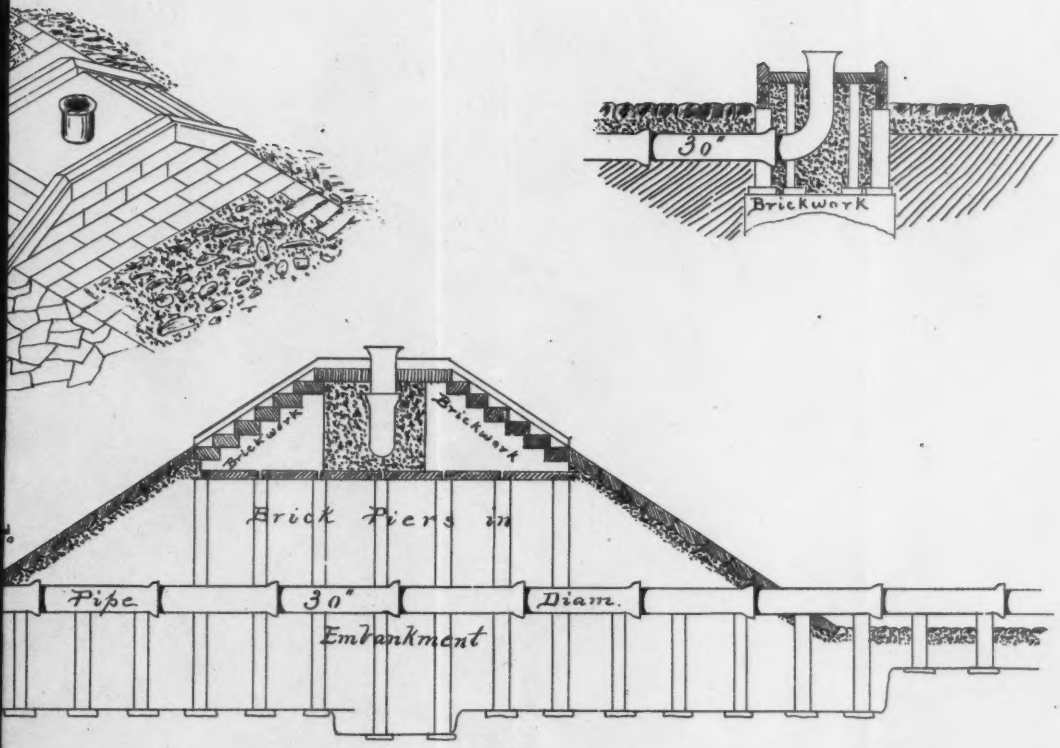
30"
Brickwork
Brickwork
Brickwork
Brick Piers in
Pipe
30"
Diam.
Embankment

platform, from which it falls down over six granite steps ten feet wide into the basins, or by using flash boards, can be turned into either at will. This method breaks up the mass, and thoroughly ærates all the water pumped into the basins, thus further tending to purify it and increase its desirability for domestic and general purposes. The top of the overfall is at the same height as the main banks.

In the middle of the south bank is the gate house with its massive granite foundation starting eleven feet below the bottom of the reservoir. In this building are situated double copper wire cloth screens of three-eighth inch mesh, also the gates controlling the delivery and separating one basin from the other.

A thirty inch supply main extends from the reservoir down to the interior of the city. The distributing mains, of which there are fifty-two miles in use, are all of coated cast iron, ranging from six to thirty inches inside diameter, supplying four hundred and ninety Lowry hydrants, and controlled by six hundred and forty stop gates.

Rubber coated and galvanized wrought iron has been extensively used as service pipe, but lead is now taking its place. There are four thousand three hundred services, measuring twenty-seven miles, supplying about eleven thousand takers including thirty-five thousand persons in dwellings and boarding houses.

The income from water rates and metered water for the year 1868 amounts to $77,793.17. Bonded debt $1,300,000.00.

WATER WASTE.

BY DEXTER BRACKETT, C. E.

Read at New Bedford, Mass., June 17, 1886.

That from 33 to 50 per cent. of the water consumed by the larger cities of this country is not used but wasted, is now generally accepted as a well established fact by all officials having charge of water supplies. Nearly every annual report contains some reference to the subject, but as to the causes of the waste and the best methods of dealing with the question of its prevention, there is not a perfect unanimity of opinion.

To prove the existence of waste, nothing more is required than an inspection of the following table:

		Population.	Daily Average Consumption. Gallons	Gallons per head per day.	Number of Services.	Cons'pt'n per service in gal.	No. of meters and motors.
Chicago,	1885	760,000	91,647,600	120.9	98,688	928	3374
Buffalo,	"	250,000	28,606,560	114.4	22,735	1258	125
Cleveland,	"	192,000	17,950,700	93.5	18,411	975	1175
Philadelphia,	"	970,000	68,945,260	71.1			305
Boston,	"	453,000	32,344,550	71.2	67,738	477	5020
Cincinnati,	"	310,000	19,800,400	64.0	28,522	694	1686
Louisville,	"	159,000	9,920,340	62.4	9,709	1022	509
Lowell.	"	64,000	3,561,000	55.0	6,913	515	1421
Cambridge,	"	62,000	3,082,884	49.7	8,731	353	195
Providence.	"	120,000	4,730,556	39.4	11,989	395	6648
Fall River,	"	56,863	1,488,137	26.2	3,708	400	2569

From the above it appears that the average inhabitant of the city of Chicago uses or wastes 120.9 gallons of water per day, while the citizens of Providence and Fall River are content with one-third of that amount.

The city of Boston, having expended five million dollars during the years 1872-75 in procuring an additional supply of water, found within a very few years after the completion of the works, that the consumption was increasing to such an extent, that the safe capacity of the new works would soon be exceeded unless the consumption could be reduced.

The object of the writer in this paper is to present an account of the methods employed, and of the results accomplished, during the past five years, in the prevention of waste in the city of Boston with the hope that the record may be of some value to those who are interested in the welfare of other water supplies.

In the year 1879 Mr. J. P. Davis, then City Engineer of Boston, in his annual report to the Water Board, considered at length the general subject of water waste, and by his recommendation experiments were made in 1881, in the Charlestown district, with the Deacon Waste Water Meter System, which had been successfully used in Liverpool and other English

cities. Between May 10, 1881, when the use of the meters and the inspection system was begun, and Nov. 18 of the same year when the experiments were concluded, the daily average consumption of 21,760 people was reduced from 58.5 gal. to 37.7 gal. per head or 450,000 gallons per day. This result was so favorable, that six more meters were obtained in 1883 and in the following year the number was increased to 75, of which 72 are now set and in use on the Cochituate system and a portion of the Mystic Works, measuring the consumption and waste of about 300,000 people.

The Waste Water Meter does not, like the ordinary recording meter register the quantity which has passed between any two observations but it records on a diagram the rate of flow at each and every instant. Being thus able to determine the rate of consumption during the night, when the legitimate use of the water is very small, the amount of water wasted can be distinguished from that used. The meter is an invention of G. F. Deacon, engineer of the water works of Liverpool, Eng., and was first applied in that city about thirteen years ago.

It consists of a hollow composition cone having its small end upwards, and containing a composition disk of the same diameter as the small end of the cone. A vertical spindle attached to the upper surface of this disk is suspended by a fine wire which passes through a stuffing box in the top of the chamber, over a pulley and supports a counterbalance weight. This weight is so adjusted as to hold the disk at the top of the cone when the water is at rest; when any water is drawn through the meter, the disk is pressed downwards toward the bottom of the cone, its position depending upon the quantity of water passing through the meter. A pencil attached to the wire records the motions of the disk on a drum which is revolved by clock work once in twenty-four hours.

The method adopted for detecting, measuring and preventing the waste is as follows: The meter is placed permanently in a box under the sidewalk and connected with the street main, in such a manner that by closing the valves on the mains, all the water used in a given section will be drawn through the meter.

The pencil will then record upon the diagram, the rate of consumption in the district supplied through the meter, and the rate at any time during the twenty-four hours can be seen from an inspection of the diagram.

The method of inspection where the service pipes have sidewalk stopcocks is as follows: After one or two diagrams have been taken from the meter to show the rate of consumption, a night inspection is made between the hours of one and four A. M. The inspector places a service wrench on each sidewalk cock and if he can, by applying his ear to the wrench, detect any indication of waste he closes the service cock and notes the time and the number of the house. This operation is continued until about four A. M. when he retraces his steps and opens all of the stopcocks previously found wasting. During this time the meter records the consumption and the diagram indicates the amount wasted from the services, the time when they were closed, and the time when the inspector began and finished his work. The premises, where indications of waste are discovered, are examined by a day inspector and the causes of waste discovered and remedied in the usual manner.

The section having been examined in this manner is then inspected by streets. This is done by closing the gates controlling an entire street and thus proceeding through the section until the entire section is shut off. By this method the amount wasting in each street is determined, and if the waste in any street is found to be disproportionately large, as is often the case, every service pipe on that street is closed and finally the main gate. The waste from the street main and from the services between the main and the curb is thus determined. As the greater portion of our services were not provided with shut off cocks at the curb, we have been obliged to modify the system and simply determine the streets in which there was a large amount of waste, and then resort to house to house inspection. For this reason, the results thus far obtained for the whole city are not as satisfactory as were those in Charlestown, where the first experiments were tried. Sidewalk stopcocks are, however, now being placed on all of our services, and about 15,000 have already been set. On about 6500 of the services have been placed the Church stopcock, which is also a waste detector.

This stopcock has, in addition to the usual opening through the plug of the cock, a small hole through the plug about 1-16 of an inch in diameter which by means of a tube reaching from the top of the plug to the surface of the street, can be connected with a pressure gauge attached to the top of the tube. When the stopcock is turned to a certain position, the opening to the house is closed, but the water passes from the street main through the small orifice to the gauge and indicates the water pressure in the main. The cock is then turned so as to allow the water to flow through the small orifice to the house, when if there is any leakage from the house fixtures the pressure immediately drops, the amount of the loss of pressure being dependent on the quantity wasting. A third position of the cock connects the gauge with the house service, the connection with the street main being closed, and the pressure will then indicate the height above the gauge at which the leak will probably be found.

These stopcocks are used in connection with the Deacon meters in the same general manner, as the ordinary stopcock; the advantage gained by their use is the ability to absolutely determine the existence and magnitude of every leak.

Experiments have also been made with the Bell waterphone, which consists of a metallic diaphragm attached to one end of a steel rod, the whole being enclosed in a hard rubber casing similar in form to the telephone receiver. The waterphone is attached to the top of an ordinary service wrench and is used to increase the sound of flowing water in the services and thus detect leaks. This device has been used to a considerable extent in Cincinnati, but the experiments in Boston were not sufficiently satisfactory to warrant the use of the device.

RESULTS ACCOMPLISHED.

What has been accomplished is shown by the following table which gives the daily average consumption from the Cochituate works for the years 1883, 1884 and 1885, together with the reduction which has been made during that time,

	1883.		1884.		1885.		Saving effected 1883 to 1885.	
	Daily average consumption. Gallons.	Gallons per head per day.	Daily average consumption. Gallons.	Gallons per head per day.	Daily average consumption. Gallons.	Gallons per head per day.	Gallons per day.	Gallons per head per day.
Jan.	34,715,500	101.6	32,162,300	92.8	26,711,900	76.0	8,003,600	25.6
Feb.	32,690,700	95.5	24,598,000	70.9	31,847,400	90.5	843,300	5.0
Mar.	34,110,700	99.6	23,711,900	68.3	27,697,200	78.6	7,413,500	21.0
April	30,617,600	89.3	21,505,700	61.8	22,720,450	64.4	7,896,150	24.9
May	32,169,500	93.7	23,708,500	68.1	22,168,400	62.8	10,001,100	30.9
June	33,419,200	97.2	26,184,600	75.1	27,214,800	77.0	6,205,400	20.2
July	36,774,000	*106.8	25,409,000	72.8	26,606,200	75.2	10,167,800	31.6
Aug.	37,141,000	107.8	25,062,500	71.7	24,686,400	69.7	12,454,600	38.1
Sept.	33,645,000	97.6	26,389,500	75.4	26,493,600	74.7	7,151,400	22.9
Oct.	29,575,800	85 6	25,022,900	71.5	24,945,500	70.3	4,630,300	15.3
Nov.	28,839,300	83.4	22,954,200	65.5	21,942,750	61.8	6,896,550	21.6
Dec.	30,174,200	87.2	24,234,800	69.0	24,724,900	69.5	5,449,300	17.7
Av'gs.	32,836,900	94.9	25,090,500	71.9	25,607,200	72.4	7,229,700	22.5

Percentage saved 23.7

*The house to house inspection begun July 16th.

The daily average consumption was reduced from 32,836,900 gallons in 1883 to 25,090,500 gallons in 1884 a saving of nearly 8,000,000 gallons per day.

Since the commencement of the inspection in 1883 more than 30,000 notices have been issued to water takers whose fixtures were in need of repairs. Although a daily saving of 8,000,000 gallons may be considered as a very favorable result, the records obtained by the Deacon meters show that there yet remains a large amount of waste.

As previously stated, the best results have not been obtainable, on account of the absence of sidewalk stopcocks on the services.

The records of 63 sections in the city proper, for the year 1885 show a daily average consumption of 56.5 gallons per head, with a consumption between one and four A. M. at the rate of 29.0 gallons per 24 hours. The average daily consumption of the 300,000 people now supplied, is now about 50.0 gallons per head and from one to four A. M. water is drawn from the mains at the rate of 25.0 gallons per day or one-half of the total daily average.

The reason that the average consumption of 300,000 people as shown by the meters is but 50.0 gallons while the total consumption of the city per inhabitant is about 68.0 gallons, is that but a very small portion of the business or manufacturing portion of the city is included in the metered sections. During the year 1885 seventeen and one half gallons per head, per day or 24 per cent. of the total consumption of the Cochituate works was consumed in premises on which recording meters were used.

The experiments which were made in Charlestown proved that the night

rate could be easily reduced to 10 or fifteen gallons. It is therefore probable that a further saving of at least 10 gallons per head, per day can be made on the Cochituate works and the consumption reduced to 60 gallons per inhabitant. The following table shows the results obtained in a few of the sections during the year 1885.

NAME OF SECTION.	Approximate population.	GALLONS PER HEAD PER DAY.							
		Total consumption			Night rate or waste.			Saving.	
								1884 to 1885.	
		1884.	1885.	1886.	1884.	1885.	1886.	Total.	night rate.
Fleet street, sec. 1	3,550	67.7	28.1	37 9	55.4	12.8	22.3	39.6	42.6
Fleet " sec. 2	1,850	93.6	54.0	55.5	75.2	33.7	35.9	39.6	41.5
Cooper " sec. 1	2,400	48.8	35.3	52.0	33.0	19.6	32.6	13.5	13 4
Leverett " sec. 1	1,400	82.4	54.1	53.3	47.4	26.8	25.7	28.3	20.6
Leverett " sec. 3	2,000	63.2	42 0	41.4	47.3	20.4	24.0	21.2	26.9
Cambridge " sec. 1	2,850	69.8	45.2	36 2	51.5	31.8	14.7	24.6	19.7
Pleasant " sec. 3	2,750	60.7	46.4	43.9	34.3	27.1	21.3	14.3	7.2
Harvard " sec. 3-4	1,950	89.1	67.3	74.4	54.6	29.1	39.6	21.8	25.5
Motte " sec. 1	2,900	67.2	25.7	33 8	33.6	8.2	13.4	41.5	25.4
" " sec. 2	1,900	87.8	49.2	68.2	57.6	22.7	29.6	38.6	34 9
" " sec. 3	2,500	62.4	28.8	43.2	42.0	11.0	21.4	33.6	31.0
Castle " sec. 1	3,100	55 4	31.7	30.9	33.2	8.4	11.1	23.7	24.8
Waltham " sec, 2	2.900	74.1	30.2	38.4	49.9	13.6	20.1	43.9	36 3
Harrison ave. sec. 1	2,800	74.4	46.6	48.0	55.8	20.1	23.3	27.8	35.7
Cedar street, sec. 1	2,550	81 9	55 8	56.4	62.3	24.1	31.2	26.1	38.2
Walnut ave..	1,500	90.7	70.3	100.8	73.5	43.6	63.1	20.4	29.9
Bowdoin st., sec. 1	1,800	91.2	44 4	50.0	61.5	21.4	29.3	46.8	40.1
Dudley " sec. 2	1,450	92.4	60.5	71.3	63,2	35.7	35.4	31.9	27.5
Averages,		75.1	45.3	52.1	51.7	22.8	27.4	29 8	29 0

The figures of consumption and waste for the year 1886, as given in the above table, are the records obtained from the first readings of the meters in the spring of 1886. A comparison of these figures, with those given for 1885, shows the increase in waste from the fall of 1885 to the spring of 1886, a period while the meters were not in use. Some of the sections show little or no increase, while the records of others, plainly show that new leaks have sprung into existence.

CAUSES OF WASTE.

The causes of waste may be classed as:

First.—Defective services and fittings on the premises of the water takers.

Second.—Defective mains and services on the premises of the city.

Third.—Negligent or wilful waste.

The defective services and fittings on the premises of the water takers are the cause of the greater proportion of the total waste. Since April first of the present year, night examinations have been made of about 6000 Church stopcocks. The buildings supplied had been subjected to a number of house to house inspections during the year 1883, 1884 and 1885 and in the fall of 1885 to an inspection similar to the one just completed. Nevertheless, during this last inspection 900 houses have been reported as wasting water and the total consumption, or waste, between one and four A. M. as shown

by the records of the gauge readings, was about 30,000 gallons per hour or 720,000 gallons per day.

As usual, the water closets and ball-cocks furnish a large proportion of the defects, 235 defective water closets, 351 defective ball-cocks, 140 defective faucets, and 79 burst service pipes, comprising the bulk of the defects reported.

Defective mains and services on the premises of the city:—

A number of cases of this class have been unearthed during the past three years and more remain to be discovered. The greater number of these leaks are discovered by the appearance of water on the surface of the street, but now and then the water escapes into a drain or sewer. These are the sources of waste which are discovered by an inspection of the Deacon meter diagrams. A number of four and six inch pipes have been found broken off and wasting large quantities of water.

Negligent and wilful waste. Many water takers, generally among the poorer class of the people, have an idea that the proper way to use a water closet is to fasten up the handle and allow the water to run constantly for the purpose, as they express it, of keeping the closet sweet. During the inspection in Charlestown in 1881, 124 cases of this kind were reported. Another cause of waste in all of our northern cities is the prevalent custom of running the water to prevent the pipes from freezing. On our Mystic works the consumption is frequently doubled by the advent of cold weather. In Charlestown, during the winter of 1881-2 a Deacon meter was used to measure the consumption of a section containing 2800 inhabitants. On Dec, 29, 1881, the daily consumption in this section was 27.6 gallons per head, while on Jan. 4, 1882, six days later, it was 61.5 gallons, and on Jan. 25, 100 gallons, showing a waste of about 70 gallons per head to prevent freezing of services.

Assuming that waste exists, and that a large proportion of it can be prevented, is its prevention advisable, and if so in what manner can it best be accomplished. The writer is very sorry to say that public opinion is not always in favor of adopting any methods of prevention. It is generally much easier to obtain an appropriation of $1,000,000 for an increased supply than of $100,000 to reduce the waste and render the available supply adequate.

The annual report of the Milwaukee Water Department for the year 1885 states that "the useless waste of water is still going on, the hoped for Legislation failed to materialize and resistance to the metering has arisen. It appears that a larger waste will be necessary to secure a proper support in the checking of the same."

For reasons of this nature the tendency in the past, even among engineers, has been to increase the supplies to meet the constantly increasing consumption, until in some cities the question has arisen as to where the supply is to be obtained. Boston found that after expending $5,000,000 in increasing the supply, further extension would be required unless the consumption could be reduced. The question in Boston has been solved as it can be in many other cities; and to-day the consumption in Boston is less than it was six years ago, notwithstanding an increase in population supplied of about 40,000 and in pipe mileage of 68 miles. Chicago wastes one half of her

supply, and pays about $50,000 per annum for fuel to pump this wasted water.

METHODS OF PREVENTION.

The principal methods of preventing waste are house to house inspection; the application of water meters on all services; the inspection and stamping of all plumbing work and material, and the use of waste detectors.

House to house inspection has been, and is at the present time, used to a greater or less extent in most American cities. If faithfully carried out, this system can be made to show excellent results. It fails, however, to detect many cases of hidden waste which are often of greater magnitude than the visible leaks, and the cost of carrying it out is very much increased by the necessity of inspecting many buildings where the fixtures are in repair. The careful owner or tenant, on whose premises no waste exists, is subjected to the same annoyance as his more careless neighbor, a feature of the system which has always been a great objection to its use. Further, the system affords no check upon the work of the inspectors, and the amount of saving is unknown, except in a very general manner.

The experience of Providence and Fall River, where the use of meters is more general than in other cities, proves that the waste of water can be prevented to a great extent by the universal use of meters. This system appeals directly to the pockets of the water takers, and without doubt reduces the waste from the house fixtures and services to a minimum, but it fails to detect leaks in street mains and service pipes, which are probably of less magnitude at present in the comparatively new systems of Providence and Fall River than in the older works of Boston, New York, and other large cities. Another thing to be considered, is the cost of the system. In the case of the Cochituate works the universal application of meters would cost at least $1,500,000. The depreciation in value, and cost of repairs and attendance, would be not less than twelve per cent. per annum or $180,000 and the interest on cost $75,000 more, making a total of $255,000 per annum. I am therefore of the opinion, that considered simply as a method of preventing waste, the system is not the most economical. There may be other considerations, such as the equitable assessment of water rates, which may render the adoption of this system advisable in certain cases.

The third method has not been introduced to any extent in American cities, but in England the system is in general use. In Manchester, a city of 390,000 inhabitants, the testing and stamping of all fittings and the constant inspection of the plumbing is solely relied upon to restrict the waste of water. The present consumption is about 24 U. S. gallons per head per day. of which 8.5 gallons are used for manufacturing, street watering and fires. About 50,000 fittings are tested and stamped each year, which includes all bibbs, stop-cocks, water closets, or other fittings used in the distribution of water. In Liverpool, 83,613 fittings were inspected in the year 1880 of which 71,969 were accepted and 11,644 rejected.

Without doubt a very large proportion of the waste is due to the use of cheap water fixtures and poor workmanship, and the sooner the English plan is adopted here, the sooner we shall strike at the root of the subject

of waste prevention. Many of our cities have already done something by licensing the plumbers but so long as cheap fixtures are allowed, they will be used and the use of meters will not entirely prevent the waste.

The fourth system, which makes use of some form of waste detector, may be considered as a modification or improvement of the house to house inspection. By the use of waste water meters and the system of inspection connected therewith, the exact location and amount of the waste is definitely determined. The inspections are made at night when the chances for discovering waste are most favorable; the only premises visited by the day inspector are those where there is known to be waste, so that the careful housekeeper is not troubled, and the time of the inspector is not wasted in useless examinations. By the records of the meters the sections of the city where the waste is large can be determined and the work of the inspectors directed to advantage, while under the house to house inspection system the time must be devoted equally to all sections.

Any of these systems, if faithfully carried out, will accomplish a large saving in the waste of water, but what is desired is the best means of accomplishing the saving, taking into consideration facility of introduction and operation, convenience to the public, and economy both of introduction and maintenance.

COMMUNICATION.

The following communication was received as we were going to press:—

3301 Haverford St., Phila., Jan. 28th, 1887.

NEW ENGLAND WATER WORKS ASSOCIATION,
Mr. Albert S. Glover, Secretary.

DEAR SIR:—

Mr. Geo. A. Ellis, in his paper on "Discharge of Water Mains" in your "Journal" for September last, quotes Poncelet's formula, as given in "Trautwine,"

$$\text{Velocity in ft. per sec.} = 48 \times \sqrt{\frac{\text{diam. in ft.} \times \text{total head in ft.}}{\text{length in ft.} + 54 \text{ diams. in ft.}}}$$

I take the liberty of sending you by this mail, for the library of your Association, a copy of the latest (1886) edition of "Trautwine," in which, as you will see by referring to page 243, I have substituted for the fixed coefficient, 48, in the above formula, a coefficient "m," varying as per the following table:—

$\sqrt{\frac{\text{diam.} \times \text{head}}{\text{length} + 54 \text{ diams.}}}$	*Diameter of pipe in feet.							
	.05	.10	.50	1	1.5	2	3	4
	m	*m*	*m*	*m*	*m*	*m*	*m*	*m*
.005	29	31	33	35	37	40	44	47
.010	34	35	37	39	42	45	49	53
.020	39	40	42	45	49	52	56	59
.030	41	43	47	50	54	57	60	63
.050	44	47	52	54	56	60	64	67
.100	47	50	54	56	58	62	66	70
.200 and over	48	51	55	58	60	64	67	70

*For intermediate diameters, &c., take intermediate co-efficients from the table by simple proportion.

These values of "m" I obtained by plotting a number of experiments with pipes of different diameters, heads, and lengths. The resulting curves indicated that the fixed co-efficient, 48, of the old formula, was decidedly too large for very small diameters with very small values of

$$\sqrt{\frac{\text{diam.} \times \text{head}}{\text{length} + 54 \text{diams.}}}$$

and vice versa, as will be seen upon comparing it with "m" in the above tables.

From the nature of the case, all formulæ for flow in pipes must be regarded as mere approximations when applied to average practice; but I think it will be found that the co-efficients in the above table generally give results more nearly agreeing with those of observation than does the fixed co-efficient, 48, especially in the extreme cases referred to.

Although Kutter's formula is given, and treated at some length, in this last edition, I believed that many would, from force of habit, prefer the older formula (it can hardly be called simpler, provided Kutter's co-efficient "c" is tabulated). I was therefore glad to be able to put it, as I believed, in shape for every-day use. Although formulæ intended for all cases cannot be justly compared when confined to a single diameter and length, I have, as a matter of curiosity, made a diagram for a 12 inch pipe, 1000 feet long, similar in construction to that given by Mr. Ellis in his paper, and comparing first our old Poncelet formula. Second, Mr. Ellis' formula (as given by the curves in his diagrams) and third my "new Poncelet" ("m" varying as in the above table) with Kutter's formula, taking his co-efficient "n" of roughness respectively at .010, .011 and .012.

I find that, roughly speaking, Poncelet gives $\frac{1}{10}$ foot per second *greater* velocity for a given head than does Kutter with "*n*" = .012 (i. e., for rather rough pipes); my "new Poncelet" ("m" variable) gives $\frac{1}{10}$ foot per second *less* velocity than does Kutter with "n" = .010 (i. e., for very smooth pipes) while Mr. Ellis' formula corresponds very closely with Kutter's with "*n*" = .011 (i. e., for pipes in average condition).

It will be noticed that in our Poncelet formulæ (old and new) the "head" is the *total* head, measured to the upper surface of still water, and includes the "velocity" and "entry" heads, as well as the "friction" head.

Very Respectfully Yours,

JOHN C. TRAUTWINE, Jr.

WATER IN JAPAN,

BY W. S. CHAPLIN.

Water is of prime importance in Japan. Rice is the staple of food for all classes, and forms perhaps two-thirds of the whole food supply of the country, and only the varieties which grow on irrigated land are considered desirable. Upland rice is, to be sure, raised and eaten but it and wheat and barley are eaten only by the poorer classes. This demand for rice raised on irrigated land has led to the utilization of land so placed that it may be irrigated, to the apparent neglect of land which is above the levels of the water in the neighboring streams. The work of preparing a lot of land for irrigation is very simple. Low embankments are built along the contour lines, the land between these roughly leveled, a canal or ditch is led from above a dam or natural fall, and the work is done. The contrivances for gates, outlets, &c., are of the simplest kind and all home-made. The profits from irrigated land are so much greater than from unirrigated that the people go to great expense to bring land under irrigation. I have seen men at work removing six feet of earth and carrying it to high land, so that the surface which was left would be below the level of the nearest canal. With irrigation the quantity of manure required is very much reduced. As may be imagined, in a country with very few cattle, the question of fertilizers is a vital one. In Japan the main reliance is on human excrements, and these are carefully preserved and removed. The country is cultivated no further away from the towns than it will pay to carry the manure; and as the roads are generally passable only for small carts drawn by men, the distance is very small. There are wide stretches of country outside the limit of irrigation and profitable transport of fertilizers, which, to the unagricultural foreigner, seem valuable as farming land, but which are left untouched by the farmers. Perhaps improved communications will make this land of value. Here, as elsewhere in irrigated countries, the great source of quarrels among the farmers is the question as to the right of each to certain quantities of water, and in summer it is common to see the lanterns of the men who are watching the canals to prevent others from opening sluices and taking an undue amount of the water.

The streams are led through the streets of cities and towns which are fortunately placed so that this is possible; and these streams then form the source from whence the household supply is drawn as well as the general sewer for the town. In considering the evil effects of this double duty it must be remembered that all the excrementitious matters are in all parts of the country carefully saved and used as manure for land, and that the house offal in Japan on account of the different food and habits of the people is not nearly so offensive as in our country.

The general supply of drinking water is drawn from wells. It ought to be stated that the amount of water actually drunk as cold water is extremely small. Tea, hot water, ice-water, hot water with cherry blossoms

in it, all are drunk freely and on all occasions, but cold water is seldom used either at meals or at other times. Whether this custom has come about from noticing the evil effects of the unboiled water, or from a love of the other drinks I cannot say; but I have found that all of them relieve the thirst as well as water, and do not bring on the usual after consequences of drinking too much cold water.

The wells are not lined as are ours with stone but with wood. If you were to take a number of bottomless firkins about three and a half feet high and three feet in diameter and slip each one over the next so as to form a long cylinder you would have the usual Japanese well lining. The last "firkin" is longer than the others and reaches three feet or so above the surface of the ground. The water is drawn by the aid of a long bamboo pole having generally a bucket attached to it. It is the custom to bring the rice to the well to wash it before cooking; and the water which contains the dust of the rice is poured onto the ground near the well. In the hot season this ferments and gives rise to odors which are decidedly unpleasant, and, if the well-lining is old and decayed, it may easily cause pollution of the well which is as injurious as that from sewage.

The larger cities have in several cases quite extensive systems for the supply of water. Of these probably the Tokio system is a fair type, and, as I am more familiar with that than any other, I will describe it.

When Iyeyas, the great ruler of Japan, decided to make Tokio his headquarters, it was probably little more than a fort and a village, or perhaps several small villages, scattered over the low land which borders the Sumida River. But one part of his policy was to have the nobility under his eye, so he ordered them all to reside in Tokio; and this caused a very rapid increase in the population, as may be understood when it is remembered that some had armed followers to the number of one thousand, and each follower had his family. The city covers a range of hills south of the river and along the bay, and spreads from them over the low land to the water. This low land has been deposited by the river and consequently is but little above its surface; and hence the water obtained here is generally bad, and in places near the shore of the bay, brackish. There was probably a demand for better water, and over two hundred years ago the works were carried out which, without material change, have supplied Tokio until to-day. The engineer was a farmer, which does not seem so strange when we consider that the farmers were generally better versed in the conveyance and distribution of water than any other class. Going about twenty miles west of Tokio he chose a site for the beginning of his canal where the river is somewhat narrowed. Here he built a low dam in the way common in that country, by laying down a row of the long bamboo baskets filled with stone (called jacago or snake baskets); this served to turn the water into the canal. The canal itself was skillfully placed along the plain which extends from there to Tokio, so that no high embankments, or deep excavations were needed. The velocity of the water is rather greater than we should usually allow in canals with unprotected earthen banks, but it is nearly uniform from one end of the canal to the other, which shows that the engineer had correct ideas as to the flow of water. The high velocity is beneficial because it prevents the growth of and obstruction from, aquatic plants; and the injury to the

banks is less than would be expected, as the earth here hardens under the action of water. The flow through this canal besides furnishing power for several mills, which are placed between the canal and the banks of the river, and in some instances providing for irrigation, delivers about 40,000,000 gallons of water to Tokio daily. After the canal described above had been built, a further supply was obtained from several ponds lying northwest of the city, and the two systems have since been so combined that it is now impossible to separate them. The water is delivered into the city at about its highest point, and is thence distributed to the various districts. The pipes are of wood; they are all square. The larger ones are made of planks, which, when the side of the pipe is so wide as to require more than one piece, are doweled and spiked together. The joints are all caulked with a fibrous bark. When these pipes are subjected to considerable pressure they are surrounded by frames of square timbers notched together.

The small pipes are each made from a squared timber which is hollowed out so that its section is shaped like a U; and then the top is covered with a plank which is spiked on. The connections between the ends of adjoining pipes are formed by champfering the end of one pipe, and enlarging the interior of the end of the next and driving the first into the second.

Wherever there is an abrupt change in level, or there is a branch pipe, a box is introduced which is generally high enough so that the water has a free surface. These boxes may be seen at several places in the city, rising ten or twelve feet above the level of the ground. They are usually covered. They are the most noticeable, and perhaps the least ingenious features in the whole system. They may, to some small degree, serve to make the flow in the pipes uniform, or perhaps they act as settling basins.

These wooden pipes are much more durable than would commonly be supposed. I have seen pipes which had been in the ground over one hundred years, and, though they were decayed to some extent, they were still serviceable. Probably when the small cost of labor is taken into account, and the high price of iron pipes, it is more economical for the Japanese to use wooden pipes than it would be to adopt our custom of using iron ones.

The water is not carried from the mains into the houses, but is delivered into the wells, which are usually in the street. The connections are bamboo, with the septa knocked out. Chemical examinations have shown that the water is contaminated in the distribution system; for specimens taken from the canal showed no pollution, while those taken from the wells in the lower part of the city were decidedly bad. Several theories have been advanced to account for this fact. One is that as the pipes are usually below the surface of the water in the ground, though the head is greater inside the pipes, there is a continual diffusion of the impurities which are outside of the pipes, through the wood into the pipes. Another and more probable hypothesis is, that owing to the constantly changing level of the water in the wells, which arises mostly from the small section of the bamboo pipes which connect the mains with the wells, the impure water from the ground makes its way through the leaky linings into the wells; and that the water thus polluted, is carried at times back into the mains.

The ends of the mains are carried down to the banks of the river and the shore of the bay, where the water is allowed to escape freely, thus reducing the head in the pipes, and preventing injury to them.

Such a system as I have described would probably not be very satisfactory in America, but it would, in many cases, be better than none. It is satisfactory to the Japanese, and there is little or no call for a better one. To do full justice to the skill and enterprise which were displayed by the builder of the water works it must be borne in mind that the Japanese of that day had no dump-carts, no shovels, no augurs, in fact, he had few of the tools which are considered essential by the modern contractor.

The city of Yokohama, which has almost entirely grown up since the advent of foreigners, is now being provided with a system of water works on the modern plan, under the direction of Japanese engineers. This is, I believe, the only instance where the Japanese method has been given up, except some few cases in Tokio where iron pipes have been used.

Organizations for extinguishing fires are very numerous in all the cities and villages of the country, and there are frequent occasions for these organizations to display their activity, as the buildings are very light and combustible, and fires are not uncommon in which the houses destroyed are numbered by the thousands. The firemen are all volunteers, and are the workmen who are engaged in building, the carpenters, joiners, roofers, etc. They have special dresses to wear at fires, made of thick, closely woven cotton, each having a hood to cover the head and face, and mittens for the hands and no two dresses alike.

The fire engine is a box about two and a half feet on each edge with neither suction pipe nor wheels. A pump is fixed upright in the box, and a tube some three feet long attached to the pump by a rough universal joint, serves as hose and nozzle. The water is brought in buckets from the nearest well and poered into the box. The greatest range of the stream is perhaps thirty feet, so that the engine must be placed within this distance of the building which is to be operated on. The main point of interest to the Japanese firemen seems to be neither the machine or the hose carriage, nor the trumpets, but the "banner". Every company has a "banner", which is of almost any shape, made mainly of paper, with the name of the company marked on it in large letters, and with a number of paper streamers. It seems to be made purposely to show the effects of fire. A company on the way to a fire is a very striking spectacle; the men in their fire dresses or putting them on, the engine on the shoulders of the bearers, the banner borne aloft in front and twirled and waved vigorously, and every man shouting his loudest.

Arrived at the fire, every company is for itself; confusion reigns. The streets are filled with people loaded with their goods; the fire engines are set to work without any semblance of order; the men mount the roofs with their banners and begin to throw off the tiles. Very little water is used, and the fire, especially if there is a wind, is left to burn itself out. If a house has been saved, the names of the companies and men who have worked on it are hung out in front of it; and the owner is expected to set out a meal for the men who have labored in his interests. The companies finally return with their pumps, each displaying its banner with

the greatest satisfaction if the fire has burned it or its streamers. It is a well recognized custom that the men who have tried to save a house, shall have the first chance at rebuilding it, which fact may have some connection with the undoubted worthlessness of the whole fire organization. Some years ago, an enterprising manufacturer sent a steam fire engine to Tokio and tried unsuccessfully to get the authorities to buy engines and introduce the foreign system of fighting fire. When the first fire happened the steam engine was hurried to the spot, and water was turned on with marvellous effect. The light wooden houses were torn to pieces by the streams. It is told that the regular firemen entered a most vigorous protest against such an innovation, urging that their trades would be ruined, and the manufacturer was warned that he must not interfere again. The idea of insurance against fire has never existed in old Japan, and even now that it has been introduced, it is making but little headway; and this stimulus to effort to prevent and extinguish fires is therefore lacking. The city of Tokio is so cut up by moats and canals that it would be very easy to introduce foreign machines and establishments, if only the people and the authorities were ready for them. The foreigner is struck with the vast amount of water power which is running to waste in the country. The streams rush down from the ranges of mountains which form the backbone of the island to the sea almost unhindered. Wooden water-wheels are used to some small extent, which, though ingenious in construction and cheap in cost, are not of the strength to do any great amount of work, and simple devices are found for utilizing the power of the water to pound the rice out of its husks; but with all these, the part of the water-power which is used is insignificant compared to that still undeveloped. I remember in particular one stream which in a course of about twelve miles, falls over two thousand feet. At its source a tunnel over a mile long was made some two hundred years ago to take the water from a large deep lake. The tunnel, though the roof has fallen in, in places, is still serviceable, and in the driest season of the year the stream receives through it, several hundred millions gallons of water per day. Such a splendid power would be a great source of wealth to individuals and the general community in our country, but I believe there is not a single mill on it. The cause of this great waste is not difficult to find. There are no communications, the roads are few, and roads which can be travelled by loaded teams are fewer still. If a manufacturer were to put up mills here it would still be cheaper for him to manufacture his wares in Tokio by hand, than it would be to take the stock to the mills, manufacture by machinery and then haul the goods to Tokio. Again there is no capital in the country for such undertakings, and foreigners are prevented by law and treaties from owning property outside the treaty limits, and hence they could get no security if they were to lend money to be invested in such property. The lack of communication has been recognized by the government, and railroads are now being built with commendable rapidity along the natural lines of traffic, so that in the near future the great cities of the country will be connected; but the country roads which must in every land feed the railroads which have got to be made before manufacturing in general can be profitable, and the water powers can be developed. Foreign cotton goods are very surely driving out those of native manufac-

ture, and, when foreign makers wake up to the idea that they must make articles in the style which suits the people, other domestic manufacturers must give way to the foreign ones unless the people are able to use machinery and avail themselves of the aid of steam and water power. The lack of capital is a very serious matter, and one which the authorities seem to have considered. If Japan were to be opened up to the influx of foreign capital as the United States is, it is feared very naturally that the Japanese would lose control of their own country; and if it is excluded the resources of the country cannot immediately be developed. In this dilemma, the government borrows money and lends it to aid undertakings of public importance. In this way railroads, paper manufactories, woolen mills, etc., have been built. But this plan has the objections which are always found to government aid; it stifles individual enterprise, it introduces semi-official administration, and it is in many cases worked to the interest of the promoter rather than the investor.

The natural inland water communications are very fully developed up to the needs of the people. The native boats are well designed and built and are found everywhere carrying freight; and within a few years small steamers of native build have been placed on many of the rivers and lakes. The foreigners complain that the safety of the passengers is disregarded on the steamers, but I somewhat doubt whether they will ever merit a worse reputation in this respect than the steamers on our own western rivers have earned. Navigable canals have been built in many places, either to pass dangerous stretches in the rivers, or to connect the waters of different rivers, and these canals, though of small section and poorly maintained, are of great value to the country. Much more might profitably be done in this same direction, and probably after the present excitement over railroads has somewhat subsided, this subject will again receive attention.

The good harbors of the country are comparatively few in number. The river mouths are generally obstructed by bars, which are of such a nature that the cost of removing them would be beyond the power of the government at present. The harbors at Nagasaki, Kobe and Yokohama in the south and Hakodadi in the north are fortunately good and open to foreign commerce, and these places must inevitably be the entrepots for foreign goods; but between these the harbors are generally far from satisfactory. It is a sail of thirty-six hours between Nagasaki and Kobe, the same between Kobe and Yokohama, and sixty hours between Yokohama and Hakodadi; hence may be seen the importance of this subject to commerce.

After the advent of foreigners the engineering of the country was very naturally left to them, as there had never been a recognized class of engineers or any systematic education for engineers in the land. The foreign engineers, who were doubtless men of good standing in their own lands, attacked the problems before them and solved them in the ways to which they had been accustomed, and these ways were of course in some cases unfitted for the circumstances. It was early seen that an engineer to be successful in Japan must be educated there, either in school or by experience; and schools which rank fairly with our engineering schools were established. The graduates of these schools are now scattered over the country carrying out works of all kinds, and there is every reason to be-

lieve that they will form a very important factor in the rapid development of the country. I hear of them as building water work, sewers, railroads, roads, bridges, improving rivers and harbors, and in fact doing all the work of engineers and doing it well. In their hands the treatment of water in Japan may be safely left.

NOTES AND QUESTIONS.

Of course all formulæ for the discharge of water from and through pipes are based upon the fundamental equation $v=\sqrt{2gh}$, from which it appears that the velocity (v) and so the quantity discharged, varies as the square root of the head (h). Let us suppose a case in which h (the head) equals 1 or unity, and this gives v a value which we will call its first value. Now suppose a case in h is doubled so that h equals 2. This gives v a value which we will call its second value. Now the second value of v will bear the same proportion to the first value, that the square root of 2 bears to the square root of 1.

$$\sqrt{1}=1.$$
$$\sqrt{2}=1.41.$$

Thus the second value of v exceeds the first value by 41 per cent.

If in a city like Taunton, Mass., having direct pumping, the pressure at the pumping station be suddenly raised from 55 pounds (127 ft. head) to 110 pounds (254 ft. head) (not an uncommon occurrence in case of fire) will every orifice in the distributing system, which is open under the two pressures, discharge 41 per cent. more water under fire than under domestic pressure? Communications upon this topic are invited for publication, in the next number of the Journal.

And upon this also: A certain district is to be provided with a main line capable of carrying 3000 gallons per minute. One plan provides for—a line made up of

(1) 5175 ft. of 16-inch,
3450 ft. of 20-inch,
2025 ft. of 12inch,

another proposes to substitute 16-inch for the 20-inch and provides

(2) 8625 ft. of 16-inch,
2025 ft. of 12-inch,

still another suggests a single line of (3) 9412 ft. of 12-inch.

In case (1) the friction loss is for 2000 galls. per minute.

ELLIS' TABLES.

$$51.75\times.123=6.36$$
$$34.50\times.042=1.45$$
$$20.25\times.49\ =9.92$$

Loss by friction in pounds pressure per square inch. 17.73

Case (2) $86.25 \times .123 = 10.60$
$20.25 \times .49 = 9.92$

Loss by friction, 20.52

Case (3) $94.34 \times .49 = 46.11$ pounds per square inch friction loss.

The line proposed by case (2) will cost 90 per cent., and that of case (3) 60 per cent., of the line of case (1).

But the value of either line for carrying water rapidly is inversely as the friction loss, and the loss by friction in the line of case (1) is but 86 per cent. of what it is in case (2) and only 38 per cent. of what it is in case (3). Is it fair to write then?

	Cost.	*Value.*
Line of case (1)	100	100
" " (2)	90	86
" " (3)	60	38

IN MEMORIAM.

WILLIAM RIPLEY NICHOLS.

By the death of Professor Nichols, this association has sustained a loss which its members, either from personal acquaintance or from professional knowledge, are peculiarly fitted to understand, though it can only be fully appreciated by the most intimate friends of the deceased.

William Ripley Nichols was born in Roxbury, on the 30th of April, 1847, and was therefore at the time of his death not yet 40 years of age. After graduating from the Roxbury Latin School, and spending several years in Europe with one of his instructors, he entered Harvard College, with the intention of devoting himself to the study of language. After a few months, however, illness compelled him to withdraw, and he soon afterward entered the Massachusetts Institute of Techology, where he devoted himself to the science of chemistry, and from which institution he graduated in 1869, after a most brilliant career. He was at once appointed assistant in chemistry, and in 1872 was made Professor of General Chemistry, a position which he occupied until his death. Uninterrupted and excessive labors soon undermined his naturally robust constitution, and in 1881-2 a severe attack of pneumonia, which was succeeded by empyema, compelled him to reluctantly relinquish his duties of instruction. Resuming them after a short interval, he took up his burden—far beyond his strength—and carried it to the end with a power of will rarely seen among men, and which can only be termed marvellous. It has well been said that if ever one of our race proved the utmost effects of resolution and fortitude in contesting the progress of fatal disease, that man was William Ripley Nichols.

In 1885, a serious surgical operation was undertaken, and with apparently some benefit, but a relapse soon followed, and in 1886 a voyage to Europe was undertaken, to consult eminent medical authority. A second

operation was advised and submitted to, but his strength was not sufficient to enable him to overcome its effects, and on July 14th he quietly breathed his last.

As a chemist, Prof. Nichols early attained eminence in the department of Sanitary Chemistry, and especially in that portion relating to the water supply and sewerage of cities, to which he devoted especial attention. As an authority on water analysis he stood second to none in this country, while his reputation was scarcely less extended in Europe than here. He kept an assistant constantly employed on his work, and he was noted among chemists for his conscientiousness and for the scrupulous care which he bestowed upon everything he did. He was consulted by most of the large cities and towns of New England, and by many in other parts of the country, on questions of great sanitary importance; and his more important published reports on questions of this nature, numbering over forty, testify to his activity in this line of investigation. Yet he did not neglect other fields; his abridgements of Eloit and Storer's Manuals are widely in use and highly esteemed, and he found time for non-scientific pursuits to an extent which seemed astonishing. Nevertheless it is upon his work as a Sanitary Chemist that his reputation chiefly and most deservedly rests.

As a teacher, Prof. Nichols will long be remembered by those who knew him. He was a clear and terse expositor, and he stood before his scholars as a constant source of inspiration and encouragement, and as a worthy ideal of scientific accuracy and conscientiousness. Indeed, the standard he set for himself was so high, and he held himself so unflinchingly up to it, that he was often judged severe; and it was no doubt difficult for him to appreciate the faults and struggles of characters less lofty than his own.

Prof. Nichols' large technical knowledge, even on matters of engineering detail, his appreciation of the work of the engineer, and his wide acquaintance and sympathy with members of our profession, render his death almost a personal loss to the members of this association.

G. F. SWAIN.

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